SHORELINE EROSION

The physical configuration of the California shoreline is dynamic and constantly changing due to coastal erosion and accretion. The rate of this shoreline change is determined by natural processes, such as rough seas, sea-level rise, high tides, nearshore currents, rainfall and runoff, landslides, and earthquakes, as well as human developments that can restrict or accelerate the volume of sand available for beaches. Historically, most beaches in California were relatively narrow, but varied depending on geologic setting and other processes influencing sand movement, supply, and retention. Extensive post-World War II coastal development occurred in California during one of the mildest weather periods in centuries. However, in the last 20 years the State has suffered major public and private property losses from severe erosion in such coastal areas as Marin, Santa Cruz, San Luis Obispo, Santa Barbara, Los Angeles, Orange and San Diego counties as more "normal" historic weather patterns returned. The challenges for the State of California are to better understand its changing coastline and to improve its assessment of how natural and economic resources can be protected.

BACKGROUND

California's beaches, coastal bluffs, bays, estuaries, and other shoreline features are altered according to geologic conditions, the availability of beach sand, the wave and current energy impinging on the coast, and other physical processes that affect sand movement and retention (Brown, pers. comm.; Flick 1993). A constant supply of sand is necessary for beaches to form and be maintained along this shoreline. Many human activities reduce the supply of sand that reaches the ocean and, in turn, deprive beaches of replenishment. These activities include dam construction, river channelization, and other developments. Lack of sand creates greater vulnerability for shorelines that have always been subject to varying levels of erosion. In the long-term, sand supply from inland sources may be increased through re-design of existing structures or altering water management practices. However, short-term management of shoreline erosion will likely continue to focus at the land/sea interface along the California coastline.

Sand is transported along the coast (long shore transport) by wave-induced nearshore currents, providing vital sand flow for California beaches. Construction of breakwaters, jetties, or groin fields to protect harbor entrances, maintain beaches, or protect coastal structures have had both positive and negative affects on sand movement along the shoreline. Protective structures trap sand and allow beaches to expand upcoast from the device, but can interrupt the flow of sand to other beaches. The structures protecting Santa Barbara and Oceanside harbors are two well-known examples of protective structures in California that provide benefits to the community, but also increase downcoast erosion. However, in many cases, few adverse affects have been documented and the major impact appears to be the increased width of narrow beaches, providing recreational opportunities and property protection.

Other forces, such as intense storms, can cause serious shoreline retreat (storms in 1982, 1983, and 1995 caused major damage to California's beaches). Such events occasionally force coastal residents, local governments, or State agencies to dump boulders (rip-rap) in front of threatened structures during emergency attempts to save property. Such emergency measures can be costly, ineffective, and result in unintended effects (including reduced shoreline access), although they can be effective if properly engineered and permitted by agencies of jurisdiction.

Value of California's Beaches

The inherent and economic value of California's beaches must be recognized. An economic analysis conducted by the California Research Bureau for the Resources Agency (Appendix B) determined that

ocean-dependent tourism and related recreation activities contributed $9.9 billion to the State's economy in 1992. Other recent studies have looked specifically at the economic contribution and value of California's beaches, though none of these have analyzed the role of the ocean and coast in adding value to real estate.

A preliminary report prepared for the California Department of Boating and Waterways estimates that Californians spent almost $3.4 billion on day trips to California beaches in 1995 (Potepan 1996). Given that most day trips probably did not require traveling more than 50 miles one-way, the majority of this economic impact is not captured in the California Research Bureau's study (which only analyzed vacation leisure travel, defined as traveling over 50 miles one-way or staying overnight).

Another measure of value, although somewhat controversial, is "willingness to pay." User values not measured by the market, when summed together, are called "consumer's surplus" or "net user value" (in addition to user values, there are also social, aesthetic, cultural or other benefits inherent to a resource that may not be measured by the market). Through detailed survey research, a National Oceanic and Atmospheric Administration study found that in 1989 just three Southern California beaches (Santa Monica, Leo Carillo, and the Cabrillo Pier/City of Long Beach area) had a net user value of over $357 million. Using this value, the study estimates the current asset value of the three beaches, that is the amount Californians should be willing to pay above and beyond current recreational expenditures for the beach resources given the annual net return, at almost $12.0 billion. (Leeworthy and Wiley 1993).

Estimating such values is not an exact science, but gives an idea of how much Californians value their beaches and ocean access. As a result, careful management of coastal erosion is critical for California's economic well-being. The State can ill afford the loss of billions of dollars in revenues from its thriving coastal tourism and recreation industry, or from property damage that could be avoided with proper shoreline management.

Coastal Erosion Policy Development

The natural phenomenon of coastal erosion is one of the more difficult statewide planning issues for California to manage. Over 950 miles of the State's 1,100 mile shoreline is actively eroding (Griggs, et al 1991) and California's population growth, combined with the public's desire to live and play along the ocean, continues to place tremendous pressures on this dynamic region for shoreline development.

The need to develop policies to reduce and manage coastal erosion was identified by the State Department of Navigation and Ocean Development in the 1972 California Comprehensive Ocean Area Plan. In 1975, the Coastal Zone Conservation Commission (predecessor of the California Coastal Commission) issued a Coastal Plan which recognized the need for some shoreline protective devices, but also found that seawalls, breakwaters, and groins can impact scenic resources, interrupt sand supply (often increasing erosion downcoast), and interfere with public access. When the California Coastal Act was passed in 1976, coastal erosion policies were included to address these concerns. In 1978, a memorandum was issued by the California Resources Agency to its departments, boards and commissions to provide policy guidance regarding shoreline erosion issues (Appendix I). Although the policy direction in this memorandum is still being used during some State agency reviews of shoreline projects, the document has never been re-evaluated or updated. Determining the best methods for reducing shoreline erosion and protecting coastal structures is frequently done by State and local agencies on a case-by-case basis, which can hinder regional approaches to managing shoreline erosion.

Jurisdictional Overview

In California, the primary government agencies involved with shoreline erosion issues are the U.S. Army Corps of Engineers (Corps) and the Federal Emergency Management Agency (FEMA) at the federal level, and the California Department of Boating and Waterways (DBW), California Coastal Commission, San Francisco Bay Conservation and Development Commission (BCDC), California State Lands Commission, California State Coastal Conservancy, California Department of Conservation's Division of Mines and

Geology (DMG), and California Department of Parks and Recreation (DPR) at the State level. The Corps, DBW, and sometimes the Coastal Conservancy are involved with funding shoreline maintenance projects, while the DPR, as a land manager, has to decide whether or where to re-build and/or protect its facilities after major storms. FEMA has a variety of programs to provide assistance during major incidents of flooding and storm damage, and to assist with efforts to re-build damaged facilities. The California Coastal Commission, State Lands Commission, and BCDC (within San Francisco Bay) are the primary State agencies with regulatory authority over proposals to build coastal protective structures, while the DMG is the lead in identifying geologic hazards for the State. Local governments also process a number of permit actions that involve shoreline protection devices.

ISSUE ANALYSIS

Shoreline management strategies may be necessary to protect existing coastal structures, maintain harbor entrances, improve the design of existing protection devices, or create large sandy beaches. The multiple approaches available for managing shoreline erosion illustrate the challenges faced in choosing a particular strategy, which may include dredging, constructing protection devices, nourishing beaches with sand, relocating threatened structures to safer ground, or avoiding development in areas where coastal erosion would pose unacceptable hazards.

Substantial engineering analyses of local conditions are necessary to determine the viability of any management option. Alternatives range from no action to complex solutions, such as combining protective devices and beach nourishment to create an equilibrium where a beach is maintained while allowing sand movement to continue down coast. The costs and benefits of these approaches must be thoroughly evaluated by federal, state, and local governments, the public, and the private sector in coordination with one another. This is critical since the technical information for evaluating project design, environmental impacts and financing is often dispersed among multiple organizations.

Constructing a Protection Device

Constructing a "hard" protection device, such as a revetment, bulkhead, seawall, or breakwater, is historically the most common approach to reducing shoreline erosion and protecting private or public structures. These devices reduce wave attack and backshore erosion and are often used to protect infrastructure serving the public. For example, the 6000-foot seawall in Carlsbad protects a utility corridor and the only north-south thoroughfare along this portion of coast, other than Interstate 5. The O'Shaughnessy seawall at Ocean Beach in San Francisco has protected Highway 1 since 1929 and is a similar example. These devices provide greater public safety by protecting infrastructure and improving public access.

Protective devices have positive benefits, although the adverse impacts of these structures must also be considered, including limiting public access to the shoreline, increasing erosion on adjacent areas, restricting sand input from protected bluffs, and increasing visual disruption along the shore. Additionally, these devices are sometimes constructed on an emergency basis during heavy storm activity without proper engineering or appropriate materials. This can lead to eventual failure of the device and create subsequent public nuisances or hazards along the beach. While protective devices may be constructed to protect existing development or coastal-dependent facilities, the California Coastal Act requires that new, non-coastal dependent developments not be built if it is known that the development will require a protective structure in the future. Although largely successful in implementing this policy, the Coastal Commission staff have identified some developments that ultimately required new protective devices not anticipated during the original project review.

A protective device differs substantially from beach nourishment in that it does not create new sand for a beach. “The fact is that no device, conventional or unconventional, creates sand in the surf zone. Any accumulation of sand produced by a structure is at the expense of an adjacent section of the shore. This

fact distinguishes structures and other devices from beach nourishment, which addresses the basic problem in coast erosion--the shortage of sand." On the other hand, many observers view the "sacrificial aspect of beach nourishment as little more than building sand castles to protect against an advancing sea." (National Research Council 1995a).

Beach Nourishment or Replenishment

Beaches can be nourished to increase their width by depositing sand up coast, directly on beaches, or in the nearshore waters offshore beaches. The primary difficulties of this approach are cost, effectiveness, and responsibility for the operation; source and method of sand extraction for nourishment use; direct smothering of marine life or important habitats; and transporting large quantities of sand to the site. Benefits include the economic and aesthetic values of a wide recreational beach and the decreased need for backshore protection.

For many years, the State and federal governments have funded beach nourishment projects in southern California, providing substantial economic and recreational benefits to the public. Historically, many of these projects have used material dredged from port and harbor construction or expansion projects. For example:

> "In Santa Monica Bay alone, over 31.6 million cubic yards of material were added to the beaches between 1939 and 1981; approximately 29.5 million cubic yards came from construction efforts whose primary objective was other than beach nourishment... In all areas of Santa Monica Bay that received nourishment, the 1990 shoreline was located well seaward of its original position. This favorable performance of the nourishment is particularly noteworthy in view of the fact that 95% of the fill material was placed on the beaches prior to 1970." (Leidersdorf, et al 1994).

The feasibility and cost-effectiveness of beach nourishment continues to be debated by policy makers and experts in the field. A publication titled *Beach Nourishment and Protection* released by the Marine Board of the National Research Council in 1995, addresses key questions regarding shoreline nourishment:

- Does beach nourishment work?
- How should success be measured?
- Is beach nourishment economically justified?
- How can beach nourishment applications be improved?
- What is the appropriate role of fixed structures with respect to beach nourishment?
- What is the role of beach nourishment in flood protection?

The findings encourage government agencies to view nourishment as a viable alternative for providing shoreline protection and restoring lost recreational opportunities. However, the findings also recognize that beach nourishment may not be technically or economically justified for all sites, particularly those with high rates of natural erosion, and that the success and environmental acceptability of nourishment projects cannot be determined without multi-disciplinary project planning, design, monitoring, and evaluation.

Relocating or Re-Building Ocean Front Structures

Structures located too close to the ocean can be vulnerable to severe damage or destruction during coastal storms. It is sometimes suggested that such structures be relocated farther inland to avoid this threat, because relocating a structure away from an eroding beach or bluff can be much less expensive than rebuilding it after a natural disaster. However, there is little incentive for this option to be considered because the property owner would have to fully finance the relocation of a structure. Conversely, if the structure is destroyed during a natural disaster, government or privately held disaster assistance is often available to partially or fully cover reconstruction costs.

A coastal development permit is not required under the Coastal Act for the re-construction of any property destroyed by a natural disaster if the replacement structure footprint remains substantially the same (no more than 10% change from the original structure). Therefore, redevelopment after a disaster could include the same design or location that contributed to the first episode of property loss.

Coastal Hazard Avoidance

New development may be directed away from areas where a new structure would require extensive engineering solutions to prevent further coastal erosion and which could still pose hazards on the property or to adjacent properties. In such cases, avoidance would reduce government and private sector costs associated with future emergency response, construction of protective devices, and disaster assistance. This approach has been adopted by the DPR in its coastal erosion policy (see Appendix I), where new structures and facilities are not constructed in areas subject to ocean wave erosion, seacliff retreat or instability. In the case where such a structure is absolutely necessary, the structure must be expendable or movable. In addition, the policy calls for measures to minimize human-induced erosion and for structural protection or re-protection of developments only when it can be shown that the protection will not negatively affect the beach or nearshore environment.

Avoidance, intended to reduce the risk of damage to property and loss of human life, is one of three goals of the federal government's Coastal Barriers Resource System, proposed for implementation on the Pacific Coast and already in place on the East Coast, in the Great Lakes region, and in the Gulf of Mexico. The other goals are to reduce unnecessary federal expenditures and to minimize damage to natural resources. This system identifies and maps high risk coastal barrier areas where future development or emergency assistance from the federal government would be unavailable, including cost-sharing programs for infrastructure improvements, federally-assisted financing, and National Flood Insurance. This system has not completely stopped development in hazardous coastal areas, but the risks of such development are assumed completely by the property owner and developer, rather than the public through government expenditures. Another way to attain the same goals (reduced development in high risk areas and reduced costs to the public for disaster assistance) is to require property owners in hazardous coastal areas to maintain adequate disaster insurance.

Shoreline Data and Expertise Dispersed

Shoreline erosion data and expertise are dispersed throughout federal, state, and local agencies, the private sector, and academia. While data can be located and used for regional planning or site specific reviews, it often requires substantial research to identify the most appropriate sources. Similarly, the fact that expertise resides within various institutions throughout the State poses a particular problem for local governments who often lack in-house expertise, adequate resources, or access to the latest data sources. Planning and regulatory processes could benefit substantially from improved methods to assemble and make available data on shoreline characteristics and hazards. Enhanced coordination, new partnerships, and improved information technology will increase accessibility to the data and expertise that currently exist.

Policy Coordination and Funding

Local communities are often faced with developing solutions to shoreline erosion problems which may have their origin far away from city or county boundaries. Effective strategies for managing shoreline erosion, like most issues described in this Agenda, require the coordinated efforts of all levels of government, the private sector, and the public. Coordinated management strategies for coastal erosion are ongoing, or being developed, in several locations along the coast.

The San Diego Association of Governments (SANDAG) has made efficient use of federal, state, and local government resources in developing a consensus-based shoreline preservation strategy for the region. The strategy was developed by a shoreline erosion committee of affected local governments and ex-officio

technical advisors from the DBW, Coastal Commission, State Lands Commission, DPR, and Corps. One result of the process is a planned partnership with the Navy to use 7 million cubic yards of material dredged from San Diego Bay to nourish beaches within the region. The Corps estimates that the total project cost will be $17 million. Of that, SANDAG has requested the federal government to provide $13 million. Governor Wilson signed SB 654 (Chapter 606, Stats. 1995) to provide an initial $700,000 for the project and also included an additional $1.65 million in fiscal year 1996-97 for project support, planning, design, construction, and operation. The Governor's 1997-98 budget proposes another $1.65 million from the State to complete the project.

The SANDAG beach replenishment project has incorporated technical data, analysis, and expertise from all three levels of government through the involvement of the ex-officio technical advisors and several technical studies including:

- *Coast of California Storm and Tidal Waves Study* (a six year, a multi-million dollar study of the region's shoreline published in 1991 by the Corps);

- *Shoreline Preservation Strategy for the San Diego Region* (adopted as regional policy by SANDAG in 1993); and

- *Shoreline Erosion Assessment and Atlas of the San Diego Region* (published in two volumes by the DBW in 1995).

Similar efforts are ongoing elsewhere along the coast. Orange county is working with the Corps of Engineers and nearby coastal cities on the "Coast of California Storm and Tidal Waves Study." The County hopes to use many of the procedures used by SANDAG to develop an effective shoreline preservation strategy based on the study's findings. Farther north, Santa Barbara County, Ventura County, and the cities of Santa Barbara, Ventura, Port Hueneme, Oxnard and Carpinteria have teamed up to form the Beach Erosion Authority for Control Operation and Nourishment (BEACON) to address regional shoreline control issues. BEACON produced the *Coastal Sand Management Plan* in 1989, but many of the strategies have not been implemented due to inadequate funding. A key focus of ongoing shoreline management will be to develop new partnerships and innovative approaches for financing shoreline management projects.

FINDINGS AND RECOMMENDATIONS

Finding

The vast majority of the California coastline is actively eroding at a rate that is determined by natural events and by many human alterations to the environment. Recent studies emphasize the economic importance of California's shoreline and the need to manage its resources. A variety of project-specific and regional approaches are addressing the issue of coastal erosion, but the Statewide erosion policy has not been reviewed since 1978.

Recommendation C-1. ***Update and revise the State's 1978 policy guidance document regarding shoreline erosion and maintenance.*** A comprehensive long-term maintenance approach for conserving, enhancing and protecting California beaches should include a thorough evaluation of existing Statewide policy to ensure that it reflects the knowledge and experience gained over the past 18 years and to correct out-of-date provisions. This policy should provide clear criteria for State review of, or fiscal participation in, project specific or regional erosion control proposals.

Finding

Much of the data and expertise to address shoreline erosion and management issues is distributed between federal, state, and local governments, the private sector, and the public. Often these assets are underutilized due to inadequate coordination between agencies and other interested parties.

Recommendation C-2. ***Develop planning and regulatory procedures for coastal project applications or regional initiatives concerning shoreline erosion and its management which more efficiently utilizes existing State agency data and expertise.*** Applications for coastal development permits or for regional management options may be reviewed by local governments, the California Coastal Commission, San Francisco Bay Conservation and Development Commission, or California State Lands Commission, depending the location of the development. However, geotechnical expertise also exists within federal agencies, other State agencies (including the Departments of Boating and Waterways, Fish and Game, Parks and Recreation, and Conservation's Division of Mines and Geology) the private sector, and academia.

Finding

Some regional coastal hazards inventory approaches have been developed for coastal communities, although no up-to-date statewide inventory is currently available. This information would be important to all interested parties, particularly local governments who may not have the resources to rapidly assemble data and information.

Recommendation C-3. ***Improve access to data and information regarding California shoreline erosion and hazards such as seismic, slope stability, flood zone, or wave generated erosion.*** A detailed inventory of available data and information could be made available on the Internet through the California Environmental Resources Evaluation System (CERES).